

ENVIRONMENTAL DETERMINANTS

Environmental Improvements Brought by the Legal Interventions in the Homes of Poorly Controlled Inner-city Adult Asthmatic Patients: A Proof-of-Concept Study

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Objectives. Domestic contamination with mold, cockroaches, rodents, and dust worsens asthma severity. This violates warranty of habitability laws in most of the states, but patients often find it beyond their means to remedy their housing situation. We aimed to study the effect of a medical–legal collaborative intervention to force landlords into providing better living conditions for patients with poorly controlled asthma. **Methods.** We retrospectively studied charts of adult patients aged 18 years or older with poorly controlled asthma (moderate or severe persistent) despite maximum medical therapy. Additionally, patients had self-reported domestic allergen exposures such as mold, cockroaches, mice or rats, and dust. The patients received legal assistance to improve their domestic environments, including fixing leaks, exterminating pests, or providing a different apartment. Post-intervention change in peak expiratory flow rate (PEFR), asthma severity class, medications, emergency department (ED) visits, hospitalizations, and requirement for systemic steroids for symptom control was assessed. **Results.** Data were available for 12 patients (9–12 months pre-intervention and 6–12 months post-intervention). Analysis of paired data revealed that mean PEFR rose by 38.6 LPM (95% CI: 9.9–67.3; $p = .014$). The number of ED visits and hospital admissions declined from 22 ED visits and 11 admissions to 2 ED visits and 1 admission (91% reduction), respectively. Of the 11 patients requiring systemic steroids, only three required these post-intervention. All patients had reductions in the dose and/or number of medications. During post-intervention, 11 (91.7%) patients dropped ≥ 2 classes in asthma severity. **Conclusions.** Medical–legal collaboration is highly effective in improving the control of inner-city asthmatics by effecting improvements in the domestic environment.

Keywords allergens, dust, fungi, jurisprudence, mice, rats

INTRODUCTION

Inner-city asthma patients have exposure to multiple domestic allergens, including cockroaches, rodents, mold, and dust, which contribute to poor asthma control (1). The geographic distribution of contaminated housing closely parallels the disease itself and supports environmental interventions for the effective control of asthma (2–5). Household allergen levels are related to housing deterioration, suggesting that housing deterioration is an appropriate target for public health intervention (5–14). Improvement of asthma symptoms through household interventions has been demonstrated in children (6–8,10,14–16) but a similar improvement in adults has not been objectively shown (17,18).

New York's Real Property Law 235-b establishes a warranty of habitability under which tenants have the legal right to an apartment and common areas “fit for human habitation” and occupants “shall not be subjected to conditions which would be dangerous, hazardous, or detrimental to their life, health or safety” (19). Most other states have similar laws (20). Persistence of the above domestic allergens is in contravention of the habitability laws. However, tenants rarely pursue legal representation for several possible reasons, such as lack of knowledge about their rights, lack of financial resources, fear of the landlord's retribution, and weakness or disability from medical conditions. Our clinic has partnered with a legal organization (LegalHealth, a division of the New York Legal Assistance Group) to assist asthma patients in improving their housing conditions. Patients receive consultation with an attorney at the same place where they receive medical care.

The goal of this retrospective proof-of-concept study was to longitudinally assess the impact of environmental

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change, brought about by a medical–legal partnership, on asthma control.

METHODS

Study Site

This study was performed in the asthma clinic at a 1028-bed, university-affiliated teaching hospital, which serves the inner-city population of the Upper West Side and Harlem in New York City. The institutional review board approved the research protocol and all patients provided written informed consent to participate in the study, including having their medical records examined by the consulting attorney.

Patient Selection

Patients included in this study were adults above the age of 18 years with a diagnosis of asthma, which was poorly controlled despite the therapy with high dose inhaled corticosteroid (ICS), long-acting β -2 adrenergic agonist (LABA), leukotriene inhibitor (LTI), and short-acting β -2 adrenergic agonist (SABA) drugs. These patients had at least one self-reported domestic or occupational allergen that was amenable to elimination by a household intervention (specifically, leaks, holes, and infestation with cockroaches, mice or rats, mold, and dust), which required action on the part of the landlord for clearance. As a part of their ongoing management, all patients with poorly controlled disease in our asthma clinic are evaluated for possible factors causing undertreated asthma, including dosing, access or compliance with medication, untreated gastroesophageal reflux disease (GERD), paranasal sinus disease, sleep apnea, cigarette smoking or environmental cigarette smoke exposure, obesity, depression, and mental illness (21–23). For the patients in this study, these conditions were actively pursued and treated; yet, their asthma remained uncontrolled despite the high medication requirements in the pre-intervention period. Patients were excluded if they had congestive heart failure, restrictive lung disease, and neuromuscular disease affecting the respiratory muscles (such as myasthenia gravis).

Asthma severity was determined at the time of each visit, utilizing the Expert Panel Report 2 (21). The parameters included in this assessment were frequency of symptoms in the day and night, frequency of albuterol requirement, and peak expiratory flow rate (PEFR) as percent of personal best. Determinations of severity were made with full maintenance medication in place. Severe exacerbations were treated with systemic corticosteroids (parenteral methylprednisolone and/or oral prednisone). All patients were seen by one attending physician (O'Sullivan M), in addition to the nurse practitioner or house staff. To maintain consistency, a template was used for initial and follow-up visits. All patients received education on techniques of medication usage, compliance, and avoidance of environmental factors affecting asthma. During the course of their management, all concerned landlords had received letters from the physician urging

them to improve housing conditions, and patients themselves had repeatedly requested interventions from their landlords. None of these methods had led to any action toward housing improvement.

Legal Intervention

When legal assistance (LegalHealth) became available at our hospital, we referred asthmatic patients who lived in self-reported contaminated housing for legal services. This group of patients lived or worked in housing infested with mold, vermin, and/or other poor conditions rendering the dwelling uninhabitable. All patients were selected because previous efforts by the patients, physicians, and/or social workers have been unsuccessful in bringing about improved living conditions.

LegalHealth has a free weekly legal clinic in the hospital, where the attorney meets with new and existing clients. In cases of deteriorated housing, the attorney explores the feasibility of moving the tenant or having the landlord to remediate the conditions. Because of the lack of affordable housing in inner-city New York, remediation tends to be the primary solution.

Whether in public or private housing, with a 2-year lease or month-to-month tenancy, habitability laws clearly place the burden of responsibility on the landlord to provide dwellings and common areas that are fit for habitation (19). Mold, rodents, leaks, and other poor conditions may render a dwelling uninhabitable and, therefore, in violation of the law, subject the landlord to lawsuits.

Few tenants know their right to invoke this law or are willing to go up against their landlords on their own, whether by demanding repairs or taking their landlords to court. The ability to access an attorney at the same place they receive medical care creates a one-stop shop for these severely affected asthmatic patients.

Once LegalHealth identifies a client's legal need as housing remediation, the attorney collects supporting medical evidence. With the client's consent, the attorney may review the medical records, discuss the client's medical condition with the physician, and directs the physician as to the type of medical statement that the physician will need to write to support the case.

While LegalHealth will take these matters to court, the power of the collaboration between medical evidence and legal demand is usually all that is necessary to provoke change.

Following a discussion between the attorney and physician, a medical statement was drafted in support of each case. The physician's statement, usually in the form of a letter that takes 5–10 min to write, is submitted to the landlord with a formal demand letter from the attorney, along with any other evidence, such as photographs or city housing department violations.

The average amount of attorney time devoted to each case was 3 hours. LegalHealth's services are free to its clients (LegalHealth and its parent, the New York Legal Assistance Group, are funded through grants from philanthropic foundations and small contributions from its hospital partner). If LegalHealth was to attribute a cost to its

service, it would amount to \$225 per case. Cases that require court action will be more time-consuming.

Parameters Studied

Demographic and anthropometric variables such as age, sex, race, weight, and height were recorded. Markers of asthma control such as PEFr, frequency of symptoms (number of episodes of wheezing per day or week, including nocturnal symptoms), and frequency of SABA use were recorded. Category of asthma severity (mild intermittent, mild persistent, moderate persistent, or severe persistent) were also recorded at each visit. Information about domestic exposures to mold, cockroaches, mice or rats, and household dust was obtained. The number of emergency department (ED) visits, hospitalizations, and steroid courses for asthma-related symptoms were recorded. The day of intervention was considered as the day on which the environmental change was effected.

Data Analysis

For objective parameters of asthma control, patients served as their own control and paired data were analyzed using the paired *t*-test for values before and after the successful legal intervention. A two-tailed *p*-value of $<.05$ was considered statistically significant. Statistical computations were performed using VassarStats (<http://vassarstats.net>).

RESULTS

A total of 35 asthma patients were referred to legal services. Of them, 13 patients were ineligible for this study due to one or more exclusion criteria. Of the remaining 22 patients, 10 patients did not have a successful legal intervention due to the lack of follow-up with legal services. Of note is that these 10 patients also had poor compliance with medical appointments and medication adherence. The remaining 12 patients followed up with legal services, had a successful intervention, and were included in the study for data analysis. These 12 patients had pre-intervention data for 9–12 months, while post-intervention data were available for 9–12 months in 11 patients, and 6 months for 1 patient. The mean age of the patients was 52 years (range: 30–81) and 9 (75%) were females. Seven (58.3%) patients were Hispanic, 4 (33.3%) were African-American, and 1 (8.3%) was Caucasian. None of the patients were active smokers. Two patients were former smokers and may have had a component of chronic obstructive pulmonary disease in addition to asthma.

Self-reported domestic exposures were cockroaches by 9 (75%) patients, mold by 8 (66.7%) patients, rodents by 6 (50%) patients, and dust by 3 (25%) patients. A detailed description of the interventions brought about through the legal assistance is reported in Table 1. Remediation of these issues was out of the control of the patients in our study. It required maintenance and structural repair of the buildings themselves, most especially repair of leaks in the elimination of mold.

After the intervention, paired data (Table 2) revealed that mean PEFr rose by 38.6 l/min (LPM) (95% CI: 9.9–67.3; $p = .014$), the mean number of ED visits dropped by 1.67 (95% CI: 0.98–2.35; $p < .001$), and the mean number of hospitalizations dropped by 0.83 (95% CI: 0.03–1.64; $p = .044$) during the follow-up period. The total number of ED visits and hospital admissions for the group declined by 91% from a total of 22 visits and 11 admissions to 2 visits and 1 admission, respectively, during the follow-up period. Of the 11 patients, who had required systemic steroids to control their symptoms, either as brief courses or as long-term therapy, only 3 (27.3%) required systemic steroids after the intervention. A reduction in the dosage of medications was possible in all patients and, in some cases, certain medications were taken off following the intervention (Table 2).

All patients dropped at least one class in asthma severity post-intervention (Table 2), with 11 out of 12 (91.7%) dropping at least two classes. It is remarkable that none of the eight patients with severe persistent asthma remained in this category following the intervention. Eleven patients maintained improved living conditions and asthma control for at least 1 year following the intervention. One patient, number 9 (Table 2), improved from a severe persistent level to mild intermittent level after the intervention. This improvement lasted for 9 months, after which point leaks and rodent infestation recurred and the asthma severity reverted to the severe persistent class. This patient's PEFr values before this recurrence were used in the post-intervention mean PEFr calculation.

The group of patients who did not have a successful legal intervention had a few common characteristics: they had poor follow-up with medical appointments and legal services and/or were unwilling to pursue legal recourse against their landlords. Of these patients, four reported mold, seven reported cockroaches, four reported dust, and six reported rodents as domestic triggers to their asthma. Pre-intervention data were available for 9–12 months for nine patients and 6 months for one patient (here, intervention date was considered as the date of referral to legal services). Post-intervention data were available for 9–12 months for six patients, 5–8 months for two patients, and 0–4 months for two patients. The mean age of the patients was 42 years (range: 26–58). Eight (80%) patients were women. Seven (70%) patients were Hispanic, 2 (20%) were African-Americans, and 1 (10%) was Caucasian. Steroid courses required for this group were five pre- and two post-intervention. The number of ED visits was unchanged (10 pre- and 9 post-interventions) and the mean PEFr was not significantly different (Pre- vs. post-intervention; paired analysis: 326 vs. 311 LPM; $p = .15$). This group was not a control group and was not matched in any way to the study group.

DISCUSSION

Our findings indicate that legal assistance is effective in bringing about considerable symptomatic and objective

TABLE 1.—Details of domestic interventions brought about after legal assistance.

Patient no.	Description of housing conditions	Results from legal intervention
1	<ul style="list-style-type: none"> • Twenty-two-year-old cabinets infested with roaches • Damaged windows were letting in cold air • Peeling paint in bathroom 	<ul style="list-style-type: none"> • Tops of cabinets replaced • Windows changed • Walls repaired and painted • Extermination monthly
2	<ul style="list-style-type: none"> • Apartment not painted in 10 years • Tiles in bathroom have fallen off allowing insects to get in • Windows broken and cannot open for fresh air • mice and rats 	<ul style="list-style-type: none"> • Tiles were fixed • Tub repaired • bathroom ceiling fixed and painted • Cabinets were replaced • Apartment was painted • extermination
3	<ul style="list-style-type: none"> • Cockroach infestation • Dust and mold in apartment 	<ul style="list-style-type: none"> • Assisted patient with moving to a different apartment offered by New York City Housing Authority (NYCHA)
4	<ul style="list-style-type: none"> • Mice and roach infestation • Leaky sink • Loose tiles in bathroom • Hole in walls, mold in hallways • Dangerous ceilings in hallways • No heat or hot water 	<ul style="list-style-type: none"> • Mold was cleaned with chemicals • Holes in walls and ceiling repaired • Sink fixed to stop leaks • Apartment was repainted • These repairs occurred 2 weeks before client was due to give birth
5	<ul style="list-style-type: none"> • Patient worked as a building superintendent and lived in the basement with extensive mold • Cockroach infestation and proven allergen sensitivity to cockroaches 	<ul style="list-style-type: none"> • Assistance in moving to another apartment with no mold or cockroaches • Obtained disability which allowed him to stop working as the building superintendent which exposed him to these triggers
6	<ul style="list-style-type: none"> • Cockroach infestation • Mold in kitchen 	<ul style="list-style-type: none"> • Hole in kitchen was fixed, stove unit was replaced
7	<ul style="list-style-type: none"> • Cockroach and rodent infestation • Mold in the apartment 	<ul style="list-style-type: none"> • Moved to apartment on another floor • New dwelling was recently painted, had a new carpet and was clean
8	<ul style="list-style-type: none"> • Mold in the kitchen triggers asthma • Hole underneath the sink 	<ul style="list-style-type: none"> • Hole in kitchen was fixed, which stopped water source and mold.
9	<ul style="list-style-type: none"> • Sewage in the apartment and ceiling • plaster falling apart • Water leak, • Roaches • rats, mice, • Mildew • Exposed electric box • Radiator lets off too much steam 	<ul style="list-style-type: none"> • Enclosed electric box • Fixed sewage pipe issue • Repaired water leaks • Replastered and repainted walls • Exterminated for roaches • Sealed holes for mice and rat entry
10	<ul style="list-style-type: none"> • Rodents • Cockroaches 	<ul style="list-style-type: none"> • Extermination for rodents and cockroaches
11	<ul style="list-style-type: none"> • Water leaks in bathroom • Buckling walls that leave that leaves a white powder • Ceiling damaged and falling 	<ul style="list-style-type: none"> • Repairs completed by closing source of water leak • plastered and repainted walls and ceiling within a week
12	<ul style="list-style-type: none"> • No gas or heat • Broken fridge • Mold • Rust • Leaking ceiling • Lead • Mold • Ceiling collapsing • Rats 	<ul style="list-style-type: none"> • Kitchen sink replaced • Apartment fumigated • Fridge repaired • Housing repairs made

improvements in poorly controlled adult asthma patients whose self-reported environmental exposures are amenable to mitigation. Improved asthma control was also accompanied by decreased ED visits and hospital admissions by over 90%, implying significant health and financial benefits. The use of systemic steroids, associated with a myriad of adverse effects, was eliminated in 73% of the patients.

It must be emphasized that the patients had been maintained on maximal medical therapy for many months prior to the environmental/legal intervention, during which other medical conditions, such as depression, GERD, sinus disease, or cigarette smoking, were medically managed. Despite these measures, the patients' asthma remained poorly controlled. The legal intervention and the subsequent improvement in their domestic

TABLE 2.—Pre- and post-intervention data for the 12 patients with successful legal intervention.

Patient	ED visits		Hospital admissions		Mean PEFR (LPM)		Asthma severity class ^a		Medication changes post-intervention ^b
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	
1	2	0	1	0	370	415	SP	MI	ICS ↓ by 80%, SABA frequency ↓, PO steroids ↓
2	3	1	0	0	175	240	SP	MI	SABA ↓, no PO steroids
3	3	1	2	1	233	200	SP	MiP	SABA ↓, PO steroids ↓
4	2	0	2	0	303	300	SP	MI	SABA ↓, no PO steroids
5	0	0	0	0	327	373	SP	MI	ICS ↓ by 50%, SABA ↓, no PO steroids
6	2	0	0	0	338	339	MoP	MI	SABA ↓, no PO steroids
7	0	0	0	0	330	403	MoP	MI	SABA ↓, off ICS/LABA
8	1	0	0	0	200	N/A	SP	MI	SABA ↓, no PO steroids
9	1	0	0	0	425	510 ^c	SP	MoP	SABA ↓, no PO steroids ^c
10	2	0	0	0	350	N/A	SP	MI	SABA ↓, no PO steroids
11	2	0	2	0	200	260	MoP	MI	SABA ↓, no PO steroids
12	4	0	4	0	300	400	SP	MI	SABA ↓, no PO steroids

Note: ED, emergency department; PEFR, peak expiratory flow rate; LPM, liters per minute; SP, severe persistent; MI, mild intermittent; MiP, mild persistent; MoP, moderate persistent; N/A, data not available; ICS, inhaled corticosteroid; SABA, short-acting β -2-agonist; LABA, long-acting β -2-agonist. "↓" Indicates a decrease in dose or frequency of use.

^aPre-intervention class implies the class of the patient assessed on the day of successful intervention and post-intervention class implies the class assessed on the last available follow-up day.

^bPost-intervention changes to medication regimen as noted on the last follow-up appointment.

^cPatient had a recurrence of domestic allergens at 9 months; the mean PEFR post-intervention but prior to the recurrence is reported.

environment were the factor responsible for bringing about a striking improvement in their asthma control.

Contamination is often beyond what patients can fix: leaks and inadequate building maintenance with uncontrolled mold, rodents, and cockroaches. The pre-intervention data support the premise in which patients who continue to live or work in such environments remain symptomatic and incur considerable morbidity (including hospital visits) despite maximum medical therapy. Physician letters and social worker assistance are often unsuccessful in getting landlords to address contamination.

Research on inner-city asthma is evolving toward an understanding that the crux of the matter lies at the intersection of medicine and societal responsibility (24–26). Our study takes this one step further. We propose that an aspect of inner-city asthma—severe housing degradation—lies at the intersection of traditional medicine and the law. Using the combined efforts of a physician and a lawyer, we have demonstrated a successful and low-cost approach to take care of a small, severely ill group of patients.

It is important to note that only a single intervention was used, without any ongoing support or legal assistance. All except one patient were able to maintain their own homes free of their self-reported allergen after the intervention. It must be noted that patient's commitment is critical to a successful intervention, because 10 out of the 22 original patients could not benefit from this due to the poor follow-up with legal services. Future studies could focus on improving this aspect of the legal intervention.

Although household interventions have been shown to improve childhood asthma, this is the first study to show a significant benefit from environmental intervention in adults with asthma (17,18). Despite the small number of patients in the study, we report statistically significant improvements in several objective parameters of asthma control. This, along with a relatively long pre- and post-intervention follow-up period, is the major strength of our study.

In contrast are several complex, long-term efforts that improved asthma control in children through ongoing household interventions, including cleaning, extermination, and supplying devices such as specialized vacuum cleaners and dust mite covers for mattresses (6–8,10). The level of repair we effected was more basic, but the results suggest that the culprits were similar, that is, cockroaches, mold, and rodents, and that a single intervention may be a useful tool to help a wider population.

Housing dilapidation, especially the damage caused by water leaks, results in the proliferation of multiple offending agents such as cockroaches, mold, rodents, and dust mites. There is a direct link between housing dilapidation and the level of cockroach and mouse allergen contamination (2–5). This, in turn, is directly related to the prevalence of cockroach sensitization and finally to the rates of poorly controlled asthma in inner-city children (2,3,12,27). Kerckmar et al. (28) have demonstrated the success of remediation of water-damaged buildings in improving the control of childhood asthma.

Mouse allergen exposure and sensitization have also been shown to be an independent risk factor for asthma morbidity (29,30), although a third study was not able to demonstrate this correlation (31). Mouse remediation has been demonstrated to bring about a modest impact (30).

The role of indoor mold as a distinct entity in an asthmatic's home is less well documented (32–34). Improvement in asthma symptoms, although with no objective improvement in asthma severity, has been demonstrated in British homes with both children and adults (17). In our study, visible mold were present in over half the homes, with recurrent leaks being the inciting agent.

This study was limited to a subset of poorly controlled severe asthma patients. The proportion of asthma patients who stand to benefit from this intervention is very likely to be much larger. Models to identify the patients who will benefit the most can be generated in order to achieve the

best outcomes for the money spent. Given that legal services are not presently covered by medical insurance companies, a cost-effectiveness analysis will be an important step in advancing research in this field. In 2008, the per-patient annual cost attributable to asthma was \$1907, and the total medical expenditure attributable to adult asthma was calculated to be \$18 billion annually (35). Intuitively, this bodes well for a favorable cost-benefit ratio for the legal intervention.

Our study has several important limitations. The study was conducted at a single center with one legal service and 12 study patients; therefore, results may not be generalizable. We did not have objective data on the severity of domestic allergen exposure before and after the intervention. We relied on the patients for evidence of improvement in conditions to define a successful intervention. It is difficult to determine whether a psychological benefit from improvement in housing conditions led to improved asthma control. However, the improvements were measurable, sustained, and significant. Data on allergy testing were not available for all the patients, so we do not have objective evidence for a causative role for these allergens in worsening the asthma control. However, we believe that objective improvements in PEFR and health care utilization after eradication of the self-reported allergens indicate at least a significant causative role.

CONCLUSIONS

Limitations notwithstanding, medical-legal collaboration is a highly effective and underutilized method of improving the care of inner-city asthma patients by bringing about improvements in their household environment.

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DECLARATION OF INTEREST

None of the authors have any financial interests relevant to this article to report.

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